

What is claimed is:

1. A magnetic navigation system for orienting a magnetically responsive medical device in a selected direction within an operating region in a subject's body, the system comprising:

a support for supporting the subject;

a magnet system for applying a magnetic field to the operating region, the magnet system comprising at least two magnets disposed on opposite sides of the operating region for applying a magnetic field of at least 0.08 Tesla in any selected direction in the operating region by a change of the position and/or orientation of the magnets within an exclusion zone volume;

an imaging system for imaging the operating region, the imaging system comprising a imaging beam source and an imaging beam detector disposed on opposite sides of the operating region, the source and the detector being carried on a C-arm which can pivot about an axis generally parallel to the longitudinal axis of the subject to change the imaging angle; the magnets of the magnet system being configured and positioned so that the C-arm can pivot through at least about 60° without impinging upon the exclusion zone of the magnets.

2. The magnetic navigation system according to claim 1 wherein the C-arm can pivot at least about 30° in either direction from the midsagittal plane of the subject.

3. The magnetic navigation system according to claim 1 wherein the C-arm can pivot through at least about 75° without impinging upon the exclusion zone of the magnets.

4. The magnetic navigation system according to claim 3 wherein the C-arm can pivot at least about 37.5° in either direction from the midsagittal plane of the subject.

5. The magnetic navigation system according to claim 1 wherein the C-arm can pivot through at least about 80° without impinging upon the exclusion zone of the magnets.

6. The magnetic navigation system according to claim 5 wherein the C-arm can pivot at least about 40° in either direction from the midsagittal plane of the subject.

7. The magnetic navigation system according to claim 1 wherein the C-arm can pivot through at least about 120° without impinging upon the exclusion zone of the magnets.

8. The magnetic navigation system according to claim 7 wherein the C-arm can pivot at least about 60° in either direction from the midsagittal plane of the subject.

9. The magnetic navigation system according to claim 1 wherein each of the at least two magnets is translatable along a first axis that extends radially outwardly from the center of the operating region, is pivotable about a second axis, generally perpendicular to the first axis, that extends through the center of mass of the magnet, and is rotatable about the first axis.

10. The magnetic navigation system according to claim 9 wherein the first axes of each of the at least two magnets are collinear.

11. The magnetic navigation system according to claim 9 wherein the first axes of each of the at least two magnets form an angle of between about 163° and 178°.

12. The magnet navigation system according to claim 9 wherein the at least two magnets are rotatable about the operating region in fixed relation to move the exclusion zones out of the way of the imaging system.

13. The magnetic navigation system according to claim 1 wherein the imaging system has an imaging zone at least +/- 15 centimeters on either side of the centerline between the imaging source and receiver, from the operating region to the receiver, that does not impinge upon the exclusion zone of the at least two magnets.

14. The magnetic navigation system according to claim 1 wherein the imaging system has an imaging zone at least +/- 20 centimeters on either side of

the centerline between the imaging source and receiver, from the operating region to the receiver, that does not impinge upon the exclusion zone of the at least two magnets.

15. The magnetic navigation system according to claim 1 wherein the exclusion zone of each of the at least two magnets is generally cylindrical exclusion zone with a frustoconical face oriented toward the operating region.

16. A magnet system for a magnetic navigation system for orienting a magnetically responsive medical device in a selected direction within an operating region in the body of a subject being supported on a support, while the operating region is being imaged with an imaging comprising an imaging beam source and an imaging beam detector disposed on opposite sides of the operating region, the source and the detector being carried on a C-arm which can pivot about an axis generally parallel to the longitudinal axis of the subject to change the imaging angle, the imaging system having an imaging zone at least +/- 15 centimeters on either side of the centerline between the imaging source and receiver, from the operating region to the receiver,

the magnet system comprising at least two magnets disposed on opposite sides of the operating region, the magnets configured so that by changing the position and orientation of the magnets each within its own exclusion zone, the magnets provide a navigating magnetic field in the operating region of at least 0.08 T in any selected direction, such that the exclusion zone permits the C-arm of the imaging system to pivot at least 60° without the imaging zone impinging on the exclusion zone.

17. The magnetic navigation system according to claim 16 wherein the exclusion zones are sized and shaped so that the C-arm can pivot at least about 30° in either direction from the midsagittal plane of the subject.

18. The magnetic navigation system according to claim 16 wherein the C-arm can pivot through at least about 75° without impinging upon the exclusion zone of the magnets.

19. The magnetic navigation system according to claim 18 wherein the C-arm can pivot at least about 37.5° in either direction from the midsagittal plane of the subject.

20. The magnetic navigation system according to claim 16 wherein the exclusions zones are shaped so that the C-arm can pivot through at least about 80° without impinging upon the exclusion zone of the magnets.

21. The magnetic navigation system according to claim 20 wherein the C-arm can pivot at least about 40° in either direction from the midsagittal plane of the subject.

22. The magnetic navigation system according to claim 1 wherein the exclusion zones are sized and shaped so that the C-arm can pivot through at least about 120° without impinging upon the exclusion zone of the magnets.

23. The magnetic navigation system according to claim 22 wherein the C-arm can pivot at least about 60° in either direction from the midsagittal plane of the subject.

24. The magnet system according to claim 16 wherein each of the at least two magnets is translatable along a first axis that extends radially outwardly from the center of the operating region, is pivotable about a second axis, generally perpendicular to the first axis, that extends through the center of mass of the magnet, and is rotatable about the first axis.

25. The magnetic navigation system according to claim 24 wherein the first axes of each of the at least two magnets are collinear.

26. The magnetic navigation system according to claim 24 wherein the first axes of each of the at least two magnets form an angle of between about 163° and 178° .

27. The magnet navigation system according to claim 24 wherein the at least two magnets are rotatable about the operating region in fixed relation to move the exclusion zones out of the way of the imaging system.

28. The magnetic navigation system according to claim 16 wherein the imaging system has an imaging zone at least ± 20 centimeters on either side of the centerline between the imaging source and receiver, from the operating region to the receiver, that does not impinge upon the exclusion zone of the at least two magnets.

29. The magnetic navigation system according to claim 16 wherein the exclusion zone of each of the at least two magnets is generally cylindrical exclusion zone with a frustoconical face oriented toward the operating region.

30. The magnet system according to claim 16 wherein each of the at least two magnets is comprised of a plurality of blocks each with a magnetization direction that in one a plurality of predetermined angular orientations that optimizes the magnetic field in a particular direction and an operating point spaced from the magnet.